

FRACTURES OF THE KNEE—"BUMPER TYPE"*

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DISCUSSION by George H. Sanderson, M. D., Stockton;
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"BUMPER fractures of the knee" is the term applied to designate a complex lesion occurring when a person is struck by an automobile bumper or otherwise with sufficient force to produce a comminuted fracture of the head of the fibula—a fracture of the external tuberosity of the tibia with an avulsion of the tibiofibular joint and a rupture of the external lateral ligament of the knee joint.

MATERIAL FOR THIS STUDY

A series of forty-five cases is recorded in which the findings are fairly constant, conveying to us the same mental picture as do the terms Colles' and Pott's for the wrist and ankle. We acknowledge that these findings are at times associated with more extensive injury, as above outlined, but have found that the treatment carried out on "bumper fractures" should be basically followed in these as well. The more commonly associated injuries are fracture of both tuberosities of the tibia, the condyles of the femur, the upper end of the tibia, and rarely a rupture of the crucial ligaments, fracture of the tibial spine, and injury to the semilunar cartilages.

In the primary survey of our patients injured by being struck down by motor vehicles, we selected the knee injury cases and added thereto all similar cases from other causes—a few were found; one had sustained a classic fracture in a fall from a stepladder; another fell on the ice at a skating rink, with the limb bent beneath her; a third fell from a tree. This survey was to ascertain the ultimate end results of all fractures involving the knee joint and its associate structures, and to devise a way of reduction, if possible, that would reduce the apparent permanent disability and the period of convalescence.

The type producing the greatest degree of permanent disability was found to be a comminution of the upper end of the fibula—the fragments separated and the entire head displaced downward, and to varying degrees backward, with complete avulsion of the tibiofibular articulation and the tearing of its ligaments. The external lateral tuberosity of the tibia is fractured through, the fragment varying in size and shape, the direction of the fracture being fairly constant in a slight oblique to perpendicular direction with reference to the joint surface. It was common to find the fragment to consist of the lateral tuberosity as far medially as the spine of the tibia. This fragment was always displaced downward. The external lateral ligament was assumed to be ruptured and preternatural lateral mobility was a constant finding—in the few operated cases it was found to be so.

* Read before the Industrial Medicine and Surgery Section of the California Medical Association at the fifty-ninth annual session, Del Monte, April 28 to May 1, 1930.

In reviewing the mechanics of production, several factors are concerned: first, the method of applying the violence to the lateral surface of the joint; second, the intrinsic factors active in the production of the displacement of fragments.

A CASE IN POINT

The writer had the good fortune to see one of our series receive her injury—while attempting to cross the street she was struck down by an automobile. The bumper of an automobile is on the level with the lower end of the femur to the average individual. The flexing of the knee, which occurs when guarding off a sudden blow, lowers the knee perhaps a few inches, the impact is received upon the lateral surface of the low thigh, an inch or so above the knee joint, the foot is fixed upon the ground or pavement—the body weight is suddenly thrown sideways and forward—the body is rotated—the muscles being set to receive the blow. In this particular case the forearm struck the edge of the radiator—the sharp pointed ornament of the radiator pierced the scalp, cutting an ugly wound—the forearm was broken, as was also the pelvis, as the front wheel of the car passed over her.

ANATOMIC BASIS

The degree of violence does not appear to be sufficient to produce so extensive a fracture in some cases. It is my belief that muscle action plays a very important part in the displacement; however, trauma is necessary as the primary cause. The knee joint is, without doubt, the strongest joint in the body. This statement is corroborated by the infrequency of its dislocation. When in complete extension with all muscles set, it offers the greatest possible resistance to injury. When semi-flexed it offers the greatest degree of movement. With the joint flexed between 165 degrees and 140 degrees, the torso in rotation as in guarding against impending injury, the muscles inserted about the knee joint are placed in a position of powerful action.

The biceps femoris muscle is a powerful leg flexor, being inserted into the head of the fibula and the external lateral tuberosity of the tibia at the joint level. When the joint is flexed it has an upward and backward pull upon its point of insertion; with the joint flexed at 90 degrees or more it has a direct backward pull at the point of insertion.

The peroneus longus muscle arises from the upper end of the fibula just distal to the biceps insertion by a long narrow attachment, and at the same level arises the extensor longus digitorum muscle. The action of these muscles would be downward when in action. Posterior on the head of the fibula and external tuberosity of the tibia is the origin of the powerful soleus muscle. Its action exerts a downward and backward pull.

The greatest displacing factor is the pull upon the head of the fibula by the biceps femoris muscle when the knee is in 160 degrees of flexion, and acting under the influence of contraction stimulated by impending injury. When the leg is

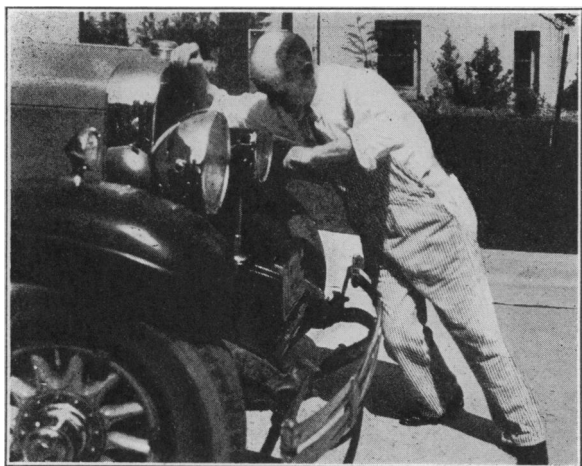


Fig. 1.—Illustrates the method of injury and shows the comparative levels between the automobile bumper and the knee joint of the average person. The fixed position of the foot upon the ground—the flexed knee and the torso rotation. The impact delivered quickly throws the torso forward to the car, with a prompt quick rebound.

in full extension and all muscles placed on tension, the knee-joint is the most stable joint in the body.

HOW THE FRACTURE IS PRODUCED

There is no question but that these fractures are the result of a direct violence delivered in a manner to cause fracture through trauma, leverage, and muscle action, producing at the same time a rupture of the external lateral ligament. The displacement of the fragments, we believe, is the result of pressure on the lateral femoral condyle and muscle pull of sufficient magnitude to avulse the tibiofibular joint and complete or increase the separation of the fibers of the external lateral ligament.

COMMENT

In the forty-five cases here reported there was rarely found any severe injury to the structures of the interior of the knee joint—that is, the cartilages, the crucial ligaments, the synovia, and the synovial sacs. The amount of effusion into the joint proper was very small and surprisingly small in the synovial sacs—no more than one sees with mild sprains of the ligaments of the knee joint. No preternatural anteroposterior movement could be demonstrated in the last twelve cases observed. A point unrecorded in our early cases, indicating a rupture of the crucial ligaments.

The absence of evidence of injury to the semilunar cartilage offers the greatest surprise of all. In none of the early cases operated could we find evidence of injury to the cartilages. This is best explained by the fact that the external semilunar cartilage has a very loose attachment and a much greater freedom of movement than the internal. The much greater liability of the internal cartilage to injury finds its explanation in the close relation and connection to the capsule by reason of which it is likely to be displaced or detached whenever the internal lateral ligament is injured; for the opposite reason the external apparently escapes injury.

The external lateral ligament is longer than the internal and runs from the lateral surface of the external condyle of the femur to a broad solid attachment to the head of the fibula. It is practically entirely separated from the capsule and the cartilage; for this reason there is but slight chance that the capsule will be torn, thus producing a large hemorrhagic effusion into the joint proper. The bursae of the joint are so placed as to escape direct injury and do not become distended with fluid.

The age incidence is as follows:

70 to 80.....	2
60 to 70.....	8
50 to 60.....	17
40 to 50.....	4
30 to 40.....	10
20 to 30.....	2
10 to 20.....	2
Total.....	45

The age from forty to eighty furnished thirty-one of the cases. The youngest patient was nineteen years of age. This patient had had a pre-existing poliomyelitis with residual paralysis of the injured leg, and was one of the five operated patients in the group. I do not believe the surgery done on this patient was of any benefit in replacing the displaced bone fragments, but a reconstruction of his external lateral ligament did increase the stability of the joint. The ligament reconstruction done on this patient consisted of turning down a strip of fascia lata of sufficient size and length to be carried through an opening made in the upper end of the fibula distal to the fracture, and carried back up to the external condyle of the femur; sufficient tension is applied to assure firm pressure. This patient was recently seen and was found to have a very stable limb, which he thinks is better than before his injury; his extension is complete and his flexion 90 degrees.

There was no associated fracture in thirty-six patients—the lower one-third of the opposite tibia and fibula was observed in two; the radius and ulna of the opposite side in two, and on the same side in two; the pelvis was fractured in two, and the opposite femur in one.

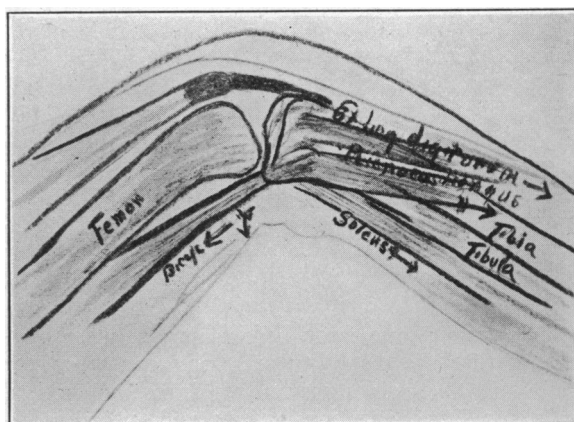


Fig. 2.—A drawing showing the direction of pull of the muscles.

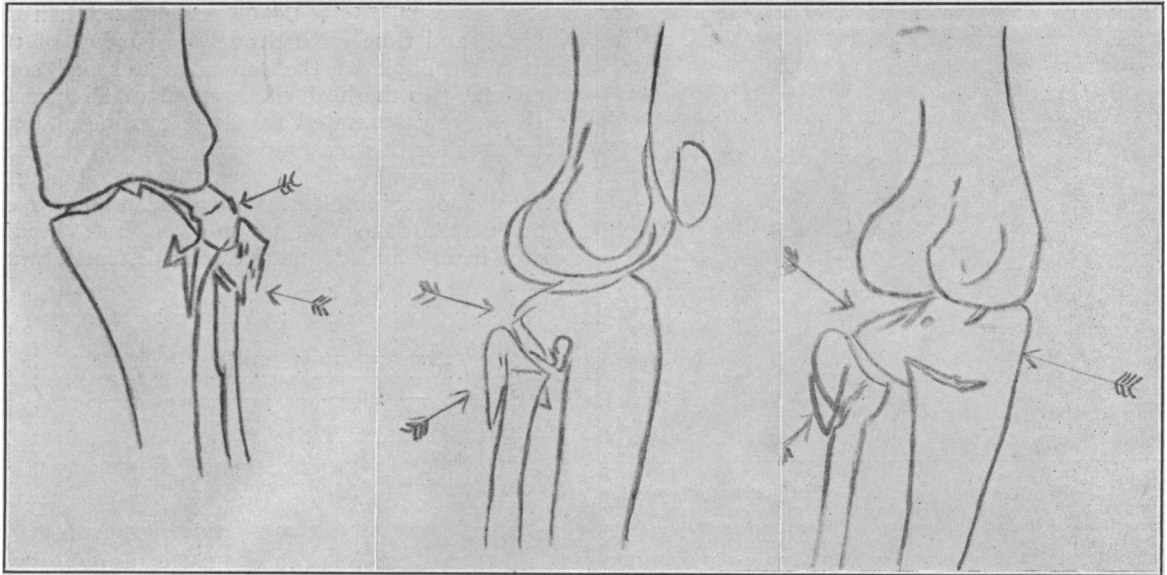


Fig. 3.—A tracing of an x-ray made in three positions of a typical bumper fracture of the knee, showing all of the factors outlined, and observed forty-five times in almost typical duplication in a series of knee joint injuries.

The period of disability was very difficult to determine. The public liability and industrial cases especially gave longer periods than the others. The younger the patient the shorter the period. The minimum period of convalescence was six months, and reports received from about 50 per cent of the first thirty-five patients showed continued complaints of pain and easy fatigue, with limited movement in all. The maximum period of disability was conservatively fixed at thirty-six months.

The postinjury complications, aside from the above complaint, were as follows: One patient had been operated four years after injury for an osteochondritis dessicans, and several bodies removed; movement was diminished after this operation, but the pain relieved. One had been operated for a chronic villus arthritis, and a complete and satisfactory synovectomy done.

The evidence collected strongly indicated that a fracture of this type gives a permanent disability in all patients over sixty years of age of approximately 50 per cent, as far as the knee joint is concerned, preëxisting osteo-arthritis and chronic synovial thickening being the principal associated findings in these. In individuals from forty to sixty, this percentage is reduced 25 per cent, and under forty the joint may be functionally good, but with the stability impaired. A young man of nineteen, examined five years after injury, showed the knee to have a full range of movement, with only moderate lateral mobility, recurrences of pain and swelling developing frequently if the knee was subjected to any degree of strain.

With the above facts before us, we were convinced that the disability and long convalescence was due to the failure in reduction. Traction, hand molding, operation, splints, and special apparatus had not given any encouragement. A plan of reduction was then decided upon and applied

with good success in six patients. A modification used on four additional patients is as follows:

MODIFIED METHOD OF REDUCTION

The earlier the reduction the better the result obtained. Ether anesthesia is not necessary; some of the milder analgesias now in vogue will suffice; we prefer to use nitrous oxid. Carefully made roentgenographs should be before you, made in true anteroposterior, lateral and semilateral positions, for these fix the degree of displacement carefully in your mind. The equipment necessary is a firm table (we now wheel the patient into the cast room on a gurney); two flat sand bags; a piece of saddler's felt six inches square and of standard thickness; and a hard rubber automobile-tire hammer; stockinet of proper size, and plaster bandage materials. One assistant is necessary.

The anesthetized patient is now turned upon the sound side; the knees are flexed from 155 to 165 degrees. This position will completely relax the biceps femoris and to a certain degree the soleus peroneus longus and longus digitorum muscles.

A sand bag is now placed between the knee and ankle, the assistant exerting pressure upon the limbs to keep them in proper alignment.

The operator stands at the back of the patient at the knee level. With the thumb and index finger of his major hand he locates the head of the fibula, which is displaced downward and backward, and then gently but firmly forces the fragmented head of the fibula upward and outward. This may be greatly aided if the assistant will gently rock and at the same time rotate the limb. This manipulation is continued until no additional replacement can be obtained, the fibula being held in place with the minor hand. The felt is now folded on itself and placed over the head of the fibula and lateral tuberosity of the tibia and held in place by an assistant. The hold on the fibula by the operator is not relaxed, but the fingers are

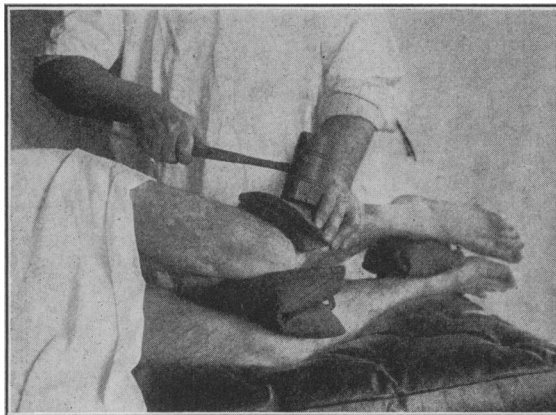


Fig. 4.—The first blow struck is obliquely upward and inward so as to force the fragment of the tibia upward and inward. The second and third blows should be square to force the tibia fragment inward (toward the mid-line).

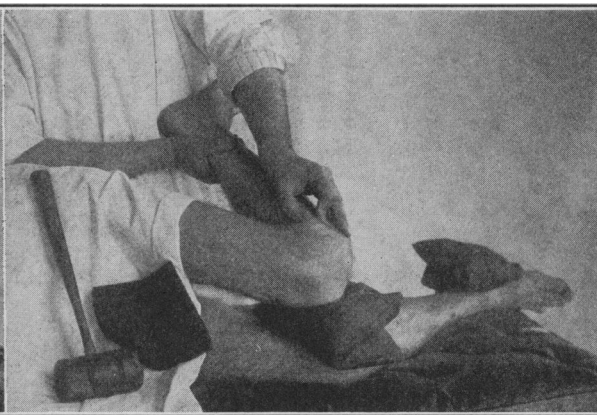


Fig. 5.—The felt is removed, the left hand encircles the fracture level firmly, the ankle is grasped with the right hand and the knee is then gently, with a few jerking movements, forced in complete flexion.

sufficiently displaced to permit contact of the felt onto the area to be pounded.

The hammer is grasped with the major hand and raised to the shoulder level of the operator. The first blow struck is obliquely upward and inward so as to force the fragment of the tibia upward and inward. The second and third blows should be square to force the tibia fragment inward (toward the mid-line). The felt is removed, the left hand encircles the fracture level firmly, the ankle is grasped with the right hand and the knee is then gently, and with a few jerking movements, forced into complete flexion. This movement will force the overcorrected fragment into impaction. We would caution here against undue roughness of this last manipulation, as the articular cartilage of the external condyle of the femur might be injured by the sharp edges of the tibial fragment, with possibilities of producing a permanent and irreparable damage to the cartilage and leading to an enchondritis dessicans.

The limb is now gently returned to about 150 degrees of flexion and one layer of stockinet or a thin layer of sheet wadding applied. The patient is returned to the back, the assistant holding the leg in flexion, heel resting on the table, and a firm plaster of paris dressing applied from the groin to just above the ankle (the foot is included if the findings are those of a bumper fracture plus). The cast is gently moulded about the patella, avoiding undue pressure. Bear in mind the relation of the peroneal nerve to the head of the fibula in your reduction, avoid striking it in pounding and pressing it with your cast.

POST-REDUCTION CARE

Bed rest for four weeks is used, but up to back rest a few days after reduction. The leg is kept elevated for seven to ten days to prevent gravity swelling. In three weeks the cast is bivalved, the anterior one-half is discarded, and the posterior is used for a splint. Radiant heat and light friction massage is instituted once or twice daily, as condition will permit. Light passive movement is also given. Special attention is directed to the training and toning of the quadriceps group to

keep up good normal tone. This the patient is instructed to do three days after the reduction. This muscle loses tone very rapidly in any leg injury and seriously impedes convalescence.

In from five to seven weeks the splint is removed and flexion by gravity is encouraged, first, by bending over a folded pillow and then over the edge of the bed. About 90 degrees of movement is usually present at the first attempt at bending, or is rapidly obtained.

Weight bearing is discouraged until the ninth to the eleventh week, depending upon the age of the patient, and then only when aided by crutches. We have tried earlier movement and weight bearing, but find that too early weight bearing is to be discouraged for two reasons: first, pressure causes a downward displacement of the soft callus and fragment; second, a soft tissue swelling develops that is quite distressing and discouraging to the patient.

SUMMARY

1. "Bumper fractures" of the knee is a term applied to a group of injuries which we have found to be as typical as a Colles' or Pott's fracture.
2. Complete reduction is just as essential for a stable joint with good function as is a complete reduction of a Colles' or Pott's fracture.
3. The method outlined we have found very satisfactory to date. No special skill is required to obtain reduction. Caution is directed to a careful consideration of the peroneal nerve and to avoid rough pounding.
4. The period of disability has been reduced one-half the usual time required, and permanent disabilities have been greatly reduced.

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DISCUSSION

GEORGE H. SANDERSON, M. D. (809 Medico-Dental Building, Stockton).—I wish to compliment Doctor Cary on his contribution to our knowledge of fractures below the knee. His term "bumper fracture" is well chosen and serves nicely for purposes of classification.

Of course, it is true that other fractures may occur as a result of being struck by an automobile bumper, and it is also true that fractures with all the charac-

teristics outlined by Doctor Cary may occur from entirely different modes of injury. For instance, I have seen two cases lately of exactly the fracture described—one in a young man thrown off a pile of sacks by an electric shock, and the other in an elderly woman who slipped off a stool and fell while cleaning her refrigerator. In my opinion, this does not detract a bit from the usefulness of Doctor Cary's term, as it fixes the fracture group in our minds descriptively and mentions its most common cause. It is much like "chauffeur's fracture," being applied to fracture of the upper third of the left ulna with dislocation of the radial head forward, usually due to accidents while driving with the left arm out the window of a closed car, although the same injury may result from a wrestling match, a fight, or what not.

I think Doctor Cary's treatment of these fractures is most ingenious, and I certainly intend to try the method. I have heretofore used traction and manual manipulation, and when this did not effect a satisfactory reduction have used a clamp as described by Böhler. I have successfully used an ordinary carpenter's wood clamp padded with felt, and cannot see but that it will work as well as the specially made Böhler os-calcis clamp.

Doctor Cary's description of the mechanism of this fracture after his experience in an exceptionally large series of fracture cases is excellent, and will be a great help to those who have to treat in the future this group of fractures, the results with which have heretofore been rather unfavorable as regards length of time of disability and permanent impairment of function.

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E. W. CLEARY, (490 Post Street, San Francisco).—I have seen quite a number of patients who had sustained fractures corresponding to the description of the lesions which Doctor Cary has named "bumper fractures." I can bear witness that these injuries produce severe permanent disability unless reduced promptly. Reduction is not often easily accomplished. If not done very soon after the injury, reduction may become impracticable. Skin lesions presenting a contaminated field for operation very often preclude open reduction.

A method of reduction by manipulation and malleting is the procedure of choice. Doctor Cary has evidently developed a system of procedure based upon careful study. Employed with discretion, it should be effective. His results speak for the efficiency of the method in his hands. There is sufficient variation in this general type of injury so that some changes in detail of technique must often be expedient.

RUPTURED BLADDER—A METHOD OF DIAGNOSIS*

REPORT OF CASES

By HARRY W. MARTIN, M. D.
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THE difficulties in diagnosing a ruptured bladder, an injury which formerly almost invariably proved fatal, until recently were very great. Our modern mode of living, with the increasing number of injuries resulting from automobile, airplane, and other machine-age traumatic accidents, many of which accidents are accompanied by fracture of the pelvis, has been responsible in part for the increasing frequency with which bladder rupture is nowadays encountered.

* Chairman's address, Urology Section of the California Medical Association at the sixtieth annual session, San Francisco, April 27-30, 1931.

* The author is indebted to Dr. Lyle C. Craig and Dr. George O. Berg of Los Angeles for coöperation in compiling data for this paper.

All medical and surgical men, but especially urologists, have gone through the anxiety incident to the treatment of a patient suffering from a bladder rupture. Any aid to better control of this serious lesion is, therefore, welcome. The diagnostic procedure I am bringing to your attention is relatively harmless and as nearly infallible as any medical procedure can be and, still more important, it provides an immediate diagnosis without waiting hours for the development of dangerous symptoms. A case in point may be in order.

Report of Case.—On the night of April 24, 1930, a man of sixty-seven was admitted to the Los Angeles County General Hospital. He had been jammed against a support by a sliding gate, and as a result had a fractured pelvis. The patient was able to urinate, but with some difficulty. A few red cells, with pus and colon bacilli, were found in the catheterized urine. On filling the bladder all the injected fluid, except four cubic centimeters, was recovered. The question which promptly arose was that of operation. Was the condition confronting us a ruptured bladder, or were the patient's difficulties the result of a bladder-neck obstruction aggravated by the injury? Because we felt certain of our diagnosis we operated. We found the rupture of the bladder, repaired it, and after three months in the hospital on a Bradford frame the man is now alive and well.

COMMENT

Whenever blood, microscopic or macroscopic, is seen in the urine after an accidental trauma, the life of the patient as well as the reputation of the doctor may be protected if this simple procedure is carried out while the patient is still on the x-ray table, where he should have been brought to diagnose his bone injury. This work can also be done in bed, using the portable x-ray, for the Bucky diaphragm is not necessary.

The following signs and symptoms, when found in a patient who has been injured, should place the physician on his guard: collapse, inability to void, vesical tenesmus, and pain over the bladder and in the lower inguinal regions. A significant sign is inguinal or flank dullness which will, of course, depend on the amount of fluid present in the abdomen.

If the rupture is extraperitoneal, then depending on the time elapsed since the injury, the picture of deep extravasation may be seen, with cellulitis, necrosis, and gangrene present.

Injecting air into the bladder and x-ray examination of the abdomen, to attempt to demonstrate air up under the liver or elsewhere in the abdominal cavity, was reported some years ago. That particular method has also been used in attempts to diagnose extraperitoneal rupture by demonstrating crepitus in the tissues. In our own experience we have not been satisfied with the air injection-x-ray procedures.

METHOD USED AT LOS ANGELES COUNTY GENERAL HOSPITAL

The method described below has been used by us in the treatment of patients on our service at the Los Angeles County General Hospital, and